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ECFA-Summary

Higgs, gamma-gamma and e-gamma physics

Maria Krawczyk[1]

Institute of Theoretical Physics, Warsaw University, Hoża 69, 00-681 Warsaw, Poland

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Abstract. Recent results obtained within ECFA/DESY and ECFA Study by the Higgs and $\gamma\gamma/e\gamma$ physics working groups are presented.

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1 Introduction

The recents results obtained within ECFA/DESY and ECFA Study for a Linear Collider (LC) for Higgs search in e^+e^- mode and in $\gamma\gamma/e\gamma$ option (Photon Linear Collider - PLC) are presented. For $e\gamma$ option results for testing anomalous gauge couplings are also shown. The extensive summary of the studies of Higgs physics in e^+e^- collisions and on physics at PLC can be found in [1] and [2], respectively.

2 Higgs studies for an e^+e^- Linear Collider

The Linear Collider is considered as a tool for precision Higgs measurements, as it was shown in TESLA TDR [3]. The further study was concentrated on more realistic simulations of essential processes, and studying of new theoretical ideas and LHC-LC synergy.

Higgs Quantum Numbers New ideas how to test the spin and CP-parity of Higgs bosons were presented recently. One bases on Higgs boson decay into ZZ [4] (results for PLC based on this idea are shown below). The other method uses the decay $H \to \tau\bar{\tau}$, with further decay of tau's into ρ, where the correlation of the decay products of τ's allows to establish the CP-parity of a Higgs boson. The study of the process $e^+e^- \to HZ \to \tau\bar{\tau}X$ for CM energy equal to 350 GeV and luminosity 1 ab^{-1} [5] shows that one can discriminate the scalar SM-Higgs with mass 120 GeV from the pseudoscalar one (with the same production rate as for H) at the 8 σ level, see Fig. 1 (Left).

Top Yukawa coupling New analysis [6] of the measurement of the Yukawa coupling of the SM Higgs particle h to top quarks is extended to higher masses, up to 200 GeV, with inclusion of the $h \to WW$, and with full 6-fermion background (BG). The results for expected relative precision for g_{tth} are presented in Fig. 1 (Right), for the energy of collision of 800 GeV, luminosity of 1 ab^{-1} and various final states (for two different background normalizations). Combining channels the precision can reach 6 to 14 %.

Supersymmetric Higgs Bosons The study of heavy Higgs bosons H and A has been performed for a particular MSSM scenario [7], in which the lighest Higgs boson h couples to gauge bosons with a full strength ($\sin(\beta-\alpha)=1$). Then H, with couplings to gauge bosons proportional to $\cos(\beta-\alpha)$, is produced in e^+e^- collision predominanty in pair with A, with cross section $\propto \sin^2(\beta-\alpha)$. The decays of H and A are mainly to fermions b and τ's, and both H and A are nearly degenerate in masses. The reconstructed difference and sum of masses, for the $b\bar{b}$ final state, with $Br(H,A \to b\bar{b})$ =0.9, presented in Fig. 2 for energy of e^+e^- collider of 500 GeV with luminosity of 500 fb^{-1} correspond to a precision 0.2 to 2.8 GeV.

3 Higgs resonance at Photon Linear Collider

A resonant production of Higgs boson(s), a unique feature of PLC, was studied in detail for Standard Model (SM), MSSM and Two Higgs Doublet Model (2HDM).

$b\bar{b}$ final state The realistic simulations of the production of SM Higgs boson with mass between 120 to 160 GeV decaying into $b\bar{b}$ were performed [8,9], including effect of overlaying events (OE) [8]. The accuracy of extraction of the $\Gamma_{\gamma\gamma}Br(H \to b\bar{b})$ is between 2 to 7 % (with OE) (Fig. 3). The realistic analysis [11] of production of heavy Higgs bosons H and A in MSSM, with parameters [10] corresponding to a case where only one SM-like Higgs particle h can be seen at LHC ("LHC wedge"), shows large potential of PLC in search of H/A (Fig. 4 (Left and Middle)).

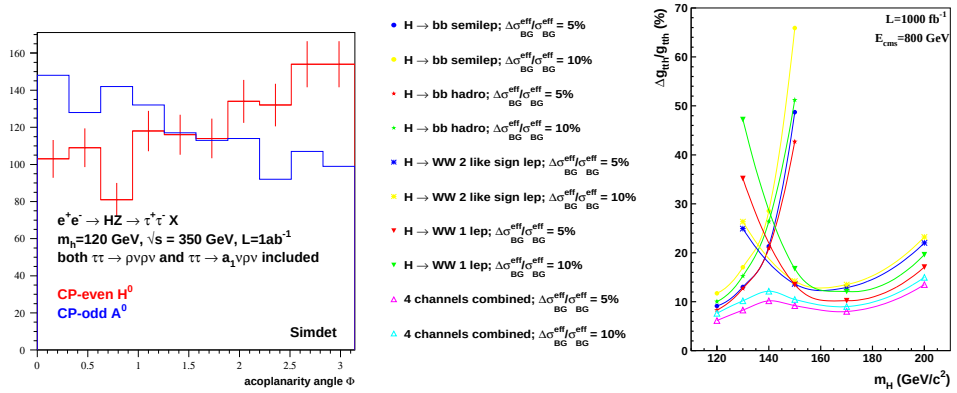

Fig. 1. Left: Distinguishing scalar from pseudoscalar using tau's; Right: Relative precision for g_{tth} from various channels.

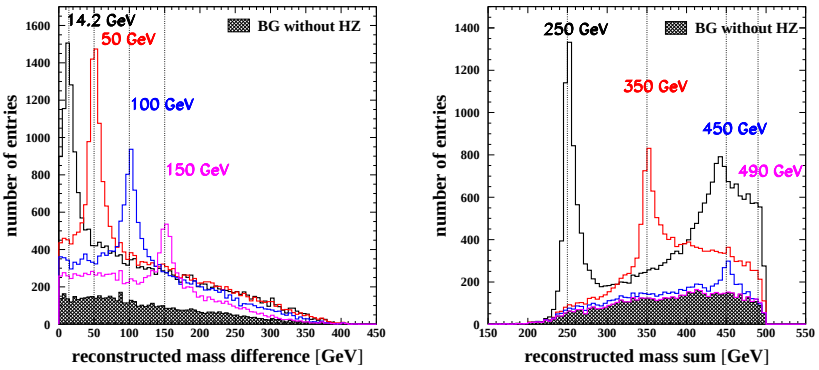

Fig. 2. Results for the reconstructed difference and sum of mass of Higgs bosons in MSSM, for the $b\bar{b}$ final state.

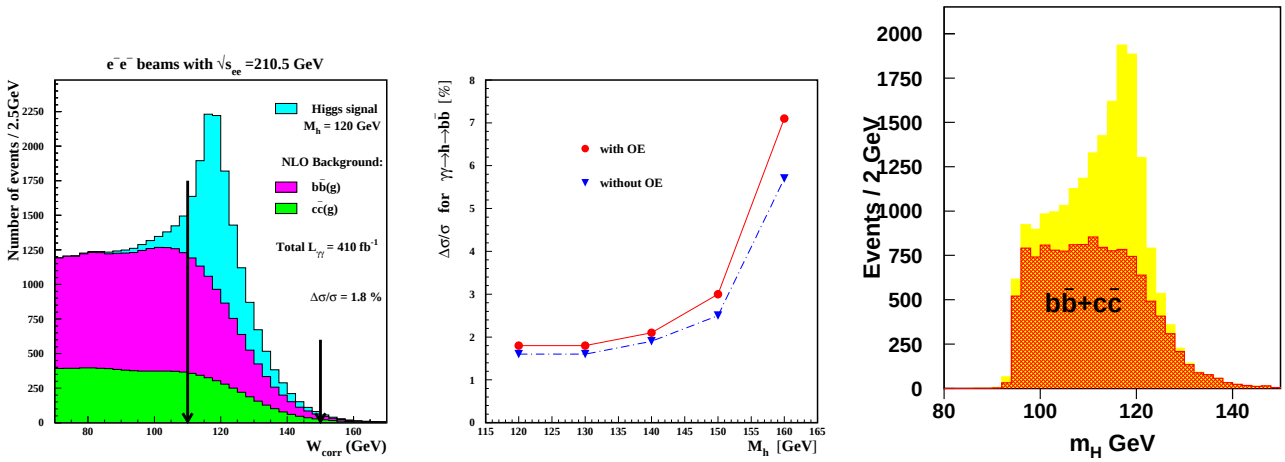

Fig. 3. Results for production of the SM Higgs with mass 120 GeV in $\gamma\gamma \to h \to b\bar{b}$ (Left: from [8], Right: from [9]); Middle: A precision of measurement of the cross section as a function of mass with and without OE included in analysis [8].

WW and ZZ final states A detailed study of Higgs boson ϕ, with or without defined CP-parity, in processes $\gamma\gamma \to \phi \to WW/ZZ$ is presented in [12]. It was found that interference with background allows to measure besides the decay width $\Gamma_{\gamma\gamma}$ also the phase of amplitude $\phi_{\gamma\gamma}$. This enlarges a discrimination power for various SM-like extensions (Fig. 4 (Right)), it is also useful to combine WW and ZZ channels. Parameters of CP-violation effects can be measured precisely: mixing angle ϕ_{HA} in 2HDM and couplings $\lambda_{A,H}$ for a generic case, shown in Fig. 5.

4 Anomalous gauge coupling in $e\gamma$ collision

A study of measuring trilinear gauge couplings, κ_γ λ_γ, from the hadronic decay of W at an $e\gamma$ - collider at energy 450 GeV was performed in [13]. An expected error are $\sim 10^{-3}$ for κ_γ and 10^{-4} for λ_γ if fit includes the azimuthal angle ϕ of final fermion (Fig. 6(Left)). The contour plot for the deviation from SM for both couplings is given in Fig.6 (Right). It was found, that the uncertainty due to the variable photon beam polarizations is large for κ_γ, while negligible for λ_γ.

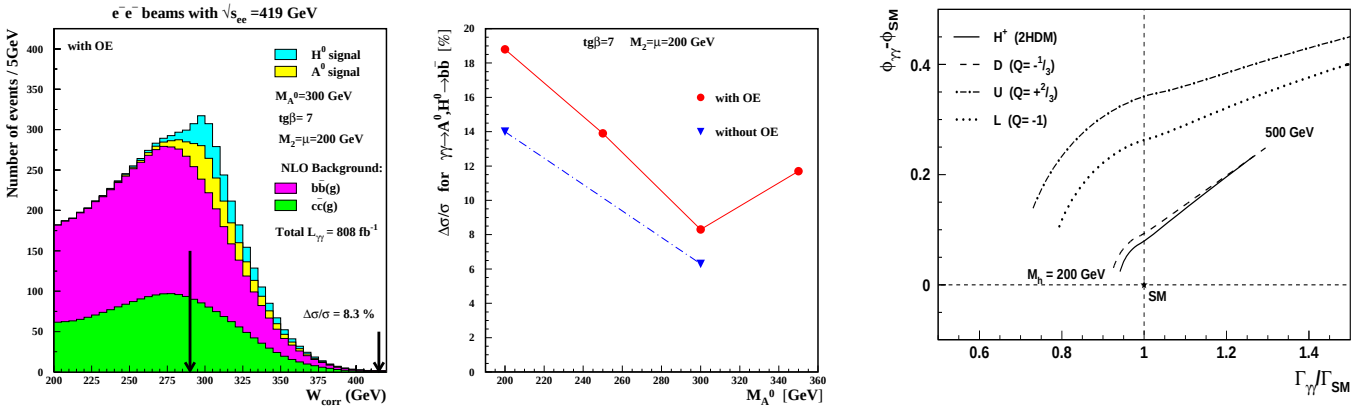

Fig. 4. Results for $\gamma\gamma \to H, A \to b\bar{b}$ in MSSM for "LHC wedge" (Left and Middle); Right: $\phi_{\gamma\gamma}$ and $\Gamma_{\gamma\gamma}$ in SM-like models

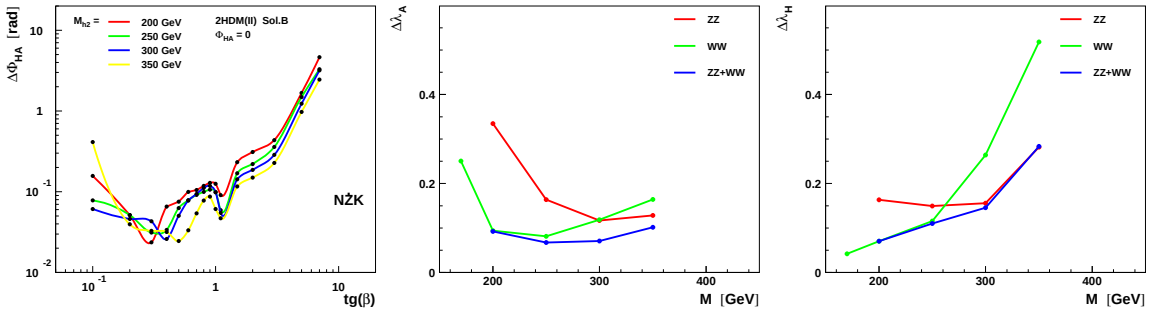

Fig. 5. Left: The precision of the determination of mixing angle between H and A in 2HDM with small CP-violation; Midle and Right: the precision of extraction of CP-even (λ_H) and CP-odd (λ_A) coupling to gauge bosons for a generic CP-violation.

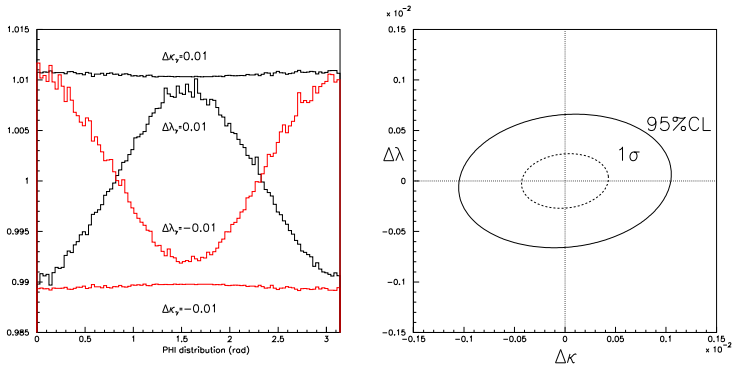

Fig. 6. Results for $\Delta\lambda_\gamma$ and $\Delta\kappa_\gamma$. Left: Deviation in ϕ distribution; Right: 95% CL (—) and 1σ (- - -) contour plots.

5 Outlook

A new ECFA Study continues precision theoretical and experimental studies of potential of LC for Higgs search and effects of new physics for e^+e^- and $\gamma\gamma$ and $e\gamma$ options.

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